

Title	DIAS Annual Report 1971-1972
Creators	DIAS, Council
Date	1971
Citation	DIAS, Council (1971) DIAS Annual Report 1971-1972. Communications of the Dublin Institute for Advanced Studies.
URL	<a href="https://dair.dias.ie/id/eprint/82/">https://dair.dias.ie/id/eprint/82/</a>

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH  
(Dublin Institute for Advanced Studies)

Annual Report of the work of the  
Institute and its Constituent  
Schools presented by the Council  
to the Minister for Education in  
respect of the Financial Year

1971-72

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH  
(Dublin Institute for Advanced Studies)

Summary of Annual Report  
of the work of the Constituent Schools  
for the year 1971-72

---

School of Celtic Studies

Changes in the staff of the School during the year included the appointment of a Research Assistant to engage in bibliographical work and two Junior Assistants. Mr. Arwyn Watkins, who was in the School as Visiting Professor in the Michaelmas term, gave a seminar on modern spoken Welsh. Other seminars and classes were given by Professors David Greene, Brian Ó Cuív and James Carney, and the Statutory Public Lecture, entitled 'The Oldest Irish Stories', was delivered by Professor Myles Dillon. The fourth in the series of symposia for university and college staffs and research workers, begun in 1969, was held in March 1972.

Following discussions with officials of the Department of Education the School undertook to provide edited texts of poems for inclusion in anthologies for the Leaving Certificate and Intermediate Certificate courses in Irish.

The full report gives details of the work of research and editing carried out in their various fields by members of the School and by extern workers.

In the field of publications twelve books (including periodicals) were published, five of them being Institute publications. Members of the School contributed thirty-four papers or shorter items to books or periodicals published elsewhere.

School of Theoretical Physics

The School was transferred from 64 Merrion Square to 10 Burlington Road in December 1971.

Professor Synge retired from his position as Senior Professor and was appointed Professor Emeritus. Professor McConnell retired from his position as Director and was replaced by Professor Ó Raifeartaigh.

Professor Synge was awarded the Boyle Medal by the Royal Dublin Society.

The work of the permanent members of the School continued along the same lines as in the previous year. In addition, Professor Carroll, who was on a year's sabbatical from Berkeley, and Professor Dineen, who was appointed Assistant Professor, worked in continuum mechanics and pure mathematics, respectively.

Distinguished short-term visitors to the School were Professors Dresden and Balazs (Stony Brook), Kovacs (Budapest), O'Connell (Louisiana), Wesley (Missouri), Polkinghorne (Cambridge), Horing (New York), Penrose (Birkbeck), Davis (North Carolina), Das (Simon Fraser) and Israel (Alberta).

Professor Dresden gave the Statutory Public Lecture, entitled 'Population dynamics', and Professor Kovacs gave a course of six lectures on molecular physics for the advanced students and faculties of the universities.

Members and Associate Members of the School gave lectures in Coleraine (3), Cork (3), U.C.D. (2), Glasgow (2), Manchester (2), Athens (2), Budapest, Warsaw, Goteborg, New York, Chicago, Utah, Vancouver, Alberta, Rochester, Berkeley, Copenhagen, Brussels, King's College, Bedford College, Swansea, Q.U.B., Paris, Nancy and at the Royal Dublin Society and the Irish Branch of the Institute of Physics. They also attended meetings at Versailles, Rome, Tel-Aviv, Zakopane, Colorado, Aberdeen, York, Amsterdam and the Rutherford Laboratory.

During the year two books were published, one book was in the press, and two Dublin Institute for Advanced Studies Communications Series A were issued. Nineteen papers were published in learned journals and twenty-five were in the press.

#### School of Cosmic Physics

##### Astronomical Section:

Methods of data analysis using correlation techniques have been used on solar data and time series and a start has been made on the requirements for handling measurements under control of a computer. Stellar photometry of variable stars has been subjected to interpretation in terms of stellar abundances of elements. Fundamental properties of asteroids have been investigated and equipment for detecting light-pulses was used successfully at Bloemfontein during the year.

##### Cosmic Ray Section:

Studies of sub-nuclear particles have been continued and several special investigations completed. The obtaining of data in the U.S.A. from plastics taken to high altitudes by balloons has been actively carried out and samples are being analysed for evaluation of composition of primary cosmic rays. Fragmentation experiments are being undertaken at CERN, Geneva, also using plastic detectors. Ultra-high-energy nuclear interactions have been studied in various ways.

##### Geophysical Section:

Features in the magnetic and gravity surveys of Ireland were investigated and several detailed conclusions were arrived at. Work of this type carried out in the Section is directly related to problems in prospecting for minerals.

The work with portable seismometers has continued and various novel problems have arisen in interpreting the results. Meteorological data have been dealt with as in former years and a classification of 6,000 rock samples is in progress.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH  
(Dublin Institute for Advanced Studies)

---

Annual Report of the work of the Institute and  
its Constituent Schools presented by the Council  
for the Financial Year 1971-72

---

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No.13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report of the work and activities of the Institute and its Constituent Schools for the financial year ending 31st March, 1972.

The general purpose which it is hoped to accomplish is clearly stated in the Act establishing the Institute, namely, the Institute for Advanced Studies Act, 1940 (No.13 of 1940) and in the Establishment Orders establishing the three Constituent Schools, namely, the Institute for Advanced Studies (School of Celtic Studies) Establishment Order, 1940, the Institute for Advanced Studies (School of Theoretical Physics) Establishment Order, 1940, and the Institute for Advanced Studies (School of Cosmic Physics) Establishment Order, 1947, and need not be referred to here. It is deemed desirable, however, to include in the report for the purposes of record certain particulars about the constitution of the Council of the Institute and the membership of the Governing Boards of the three Constituent Schools on the 31st March 1972.

The report is presented under the following principal heads:-

- I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March, 1972.
- II - Report of the Governing Board of the School of Celtic Studies.
- III - Report of the Governing Board of the School of Theoretical Physics.
- IV - Report of the Governing Board of the School of Cosmic Physics.

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March 1972.

1. THE COUNCIL OF THE INSTITUTE

Chairman:

Professor W. B. Stanford, M.A., Litt.D., F.T.C.D.

Ex-Officio Members:

J. J. Hogan, M.A., B.Litt. (Oxon.), President, University College, Dublin; Albert J. McConnell, M.A., M.Sc., Sc.D., Provost, Trinity College, Dublin; Vincent C. Barry, D.Sc., F.R.I.C., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools:

Professor David Greene, M.A.; T. K. Whitaker, D.Econ.Sc.; Professor L. Ó Raifeartaigh, M.Sc., Ph.D.; Professor P. Quinlan, B.E., D.Sc., Ph.D.; Professor P. A. Wayman, Ph.D.; Professor E. F. Fahy, M.Sc., Ph.D.

2. THE GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman:

Right Reverend Monsignor Patrick Boylan, D.D., M.A., D.Litt.

Senior Professors:

Daniel A. Binchy, M.A., Ph.D., B.L.; Myles Dillon, M.A., Ph.D.; David Greene, M.A.; Brian Ó Cuív, M.A., D.Litt.

Appointed Members:

Tomás de Bhaldraithe, M.A., Ph.D., D.Litt.; James H. Delargy, M.A., D.Litt., Litt.D.; Proinsias Mac Cana, M.A., Ph.D.; Edward MacLysaght, M.A., D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Reverend John Ryan, S.J., M.A., D.Litt.; Thomas Kenneth M. Whitaker, D.Econ.Sc.

3. THE GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman:

Albert J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.

Senior Professors:

Reverend James R. McConnell, M.A., D.Sc.; Lochlainn Ó Raifeartaigh, M.Sc., Ph.D.

Appointed Members:

George R. Keating, M.Sc.; Reverend James J. McMahon, M.Sc., Ph.D.; Thomas Edwin Nevin, D.Sc.; Patrick Quinlan, B.E., D.Sc., Ph.D.; Seán Seosamh Tóibín, M.Sc., Ph.D.; Thomas David Spearman, M.A., Ph.D. (Cantab.).

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

Edward Francis Fahy, M.Sc., Ph.D.

Senior Professors:

Cormac Ó Ceallaigh, M.Sc., Ph.D.; Thomas Murphy, D.Sc.; Patrick Arthur Wayman, Ph.D.

Appointed Members:

Patrick M. A. Bourke, M.Sc.; Peter Kevin Carroll, M.Sc., Ph.D.; Cyril F.G. Delaney, M.A., Ph.D., F.T.C.D.; Eric M. Lindsay, M.A., M.Sc., Ph.D., F.R.A.S.; Reverend Thomas P. G. McGreevy, M.Sc., Ph.D.; Patrick J. Nolan, Ph.D., D.Sc.; Cilian Ó Brocháin, M.Sc., Ph.D.; Neil A. Porter, Ph.D.; Ernest T. S. Walton, M.A., M.Sc., Ph.D., D.Sc., F.T.C.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy.

Accounts Clerk:

Mary A. O'Rourke.

Clerks:

Susan Kealy; Noreen Madden; Desmond Pender.



II - Annual Report of the Governing Board of the School of Celtic Studies for the year 1971-72 adopted at its meeting on 6 July 1972.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

David Greene, Director of the School; Daniel A. Binchy;  
Myles Dillon; Brian Ó Cuív.

Professor:

James P. Carney.

Visiting Professor:

T. Arwyn Watkins.

Assistant Professors:

Rev. Pádraig Ó Súilleabháin, O.F.M.; Gearóid Mac Niocaill (resigned 30 September 1971); Pádraig de Brún (appointed 1 January 1972).

Assistant:

Pádraig de Brún (to 31 December 1971).

Junior Assistants:

Fergus Kelly (appointed 1 October 1971); Tomás Ó Cathasaigh (appointed 1 January 1972).

Assistants (Part-time):

Mrs. Nessa Doran; Mrs. Anne O'Sullivan.

Research Assistant:

Rolf Baumgarten (appointed 1 August 1971).

Research Associates:

Heinrich Wagner; Proinsias Mac Cana.

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

John Cullen (to 30 September 1971); Fergus Kelly (to 30 September 1971); Tomás Ó Cathasaigh (to 31 December 1971); John Shaw (to 30 June 1971); Ronald Black; Mary Herbert; Arndt Wigger; Luce Diez (appointed 1 October 1971); Damian Ó Muirí (appointed 1 October 1971); Máire Ní Bhardáin (appointed 1 October 1971 - resigned 31 January 1972); Pádraig Breatnach (appointed 1 February 1972); J. C. D. Marshall (appointed 1 September 1971).

Extern Research Workers:

Dr. Cecile O'Rahilly; Louis Paul Nemo (Roparz Hemon); Rev. Anselm O'Fachtna, O.F.M.; Dr. Ludwig Bieler; Mr. I. P. Sheldon-Williams; Mr. Brynley Roberts; Mrs. Rachel Bromwich; Rev. Fergal Mac Raghnaill, O.F.M.; Rev. Martin McNamara, M.S.C.



The vacancy caused by the retirement (November 1970) of M. Louis Paul Nemo from the post of Assistant Professor was filled by the promotion of Pádraig de Brún to that grade from 1 January 1972. Approval was given for the appointment of two Junior Research Assistants, and these posts were filled by Mr. Fergus Kelly (1 October 1971) and Tomás Ó Cathasaigh (1 January 1972). During the Michaelmas term of 1971, Mr. Arwyn Watkins was Visiting Professor; his seminars on Modern Spoken Welsh were well attended and he proved a stimulating and agreeable colleague. The success of this experiment inspired the Governing Board, on the resignation of Gearóid Mac Niocaill from the post of Assistant Professor (September 1971), to ask approval for the establishment of a Visiting Professorship and a Junior Research Assistantship as an interim measure; the initial salary attaching to the Assistant Professor grade is too low to make it an attractive means of recruitment. Unfortunately, no reply was received from the Minister for Education and the staffing situation remained as unsatisfactory as in previous years.

The Governing Board recommended to the Council of the Institute that the Minister for Education should be asked to designate the Institute as an institute of higher education under the provisions of the Act setting up the Higher Education Authority; the other Schools made similar recommendations and the Council accordingly asked the Minister to do this.

## 2. RESEARCH AND EDITING

Professor David Greene continued his work on Saltair na Rann; the first 2,250 lines are now available in draft text and translation and the possibility of publishing the Adam and Eve section separately is being considered. As prolegomena to a projected work on the history of the Irish language two investigations were undertaken. The first, on the spread of palatalisation, was advanced sufficiently for tentative results to be presented to the School's symposium (March 1972); the results of the second, on the development of the verbal system of later Irish, will appear in Ériu 24 (1973). Work as editor of Ériu continued; Vol.22 appeared in December 1971, Vol.23 is in the press, and contributions

are being collected for Vol.24. See also sections 4, 10, 11.

Professor D. A. Binchy continued to work on the first proofs of Corpus Iuris Hibernici and 338 pages of these were returned to the printer for revise. He wrote an article of 60 pages for Celtica X. See also section 11.

Professor Myles Dillon completed the preparation of his book Celts and Indo-Aryans and the material was sent to the Indian Institute of Advanced Study for publication. Final proofs of Celtica IX were checked and passed for press. The typescript of the French edition of The Celtic Realms was revised, and revision of the English text for a second edition was continued. Preparation began on Celtica X and an article was written for inclusion in the volume. See also sections 3, 5, 10 and 11.

Professor Brian Ó Cuív carried out, as part of a study of the history of Early Modern Irish bardic poetry, a survey of extant material from the thirteenth century, and he presented some of his findings in the School's symposium (held in March, 1972). He completed a number of articles for publication in Celtica and Éigse; read proofs of works being prepared for publication, including those of the revised edition of T. F. O'Rahilly's Irish Dialects Past and Present and saw through the press two issues of Éigse and sent copy for a third to the printer. He continued to direct and take part in the work of indexing the contents of the Irish manuscripts in the National Library of Ireland. See also sections 4, 5, 6, 8, 9, 10 and 11.

Professor James Carney completed his work on 'The Lambeth Commentary' and the material was sent to press. 'The remote origins of amhrán', a Seán Ó Riada Memorial Lecture, was accepted for publication. See also sections 4, 10 and 11.

Rev. Pádraig Ó Súilleabháin, O.F.M. read page-proofs of the Preface, Notes and Vocabulary of his edition of Buaidh na Naomhchroiche and passed them for press. He continued to index etymological notes, notes on grammar, syntax and linguistic dating. The following journals and books

have been excerpted:- Celtica I-IX, Éigse I-XIII, Études Celtiques I-VI, Studia Hibernia I-X, Studia Celtica I-V, Gadelica, Early Irish History and Mythology, Kuno Meyer Miscellany, Féilsgríbhinn Eoin Mhic Néill, Féilsgríbhinn Torna, Messera Mhichíl Uí Chléirigh, Duanaire Finn Pt.III, Lorgaireacht an tSoidhigh Naomhtha, Desiderius, Scéthán Shacramuinte na hAithridhe, Párlament na mBan; for etymological notes only: Revue Celtique I-LI. The following articles were accepted for publication in Éigse:- (i) 'Notes on coiblidí, Diardaoin Álainn, feiste, maidir le, An bata scoir, Lámhscríbhinn Uí Mhurchú 59, roimh'; (ii) a short article entitled 'A gúl gion gur lámhadh lé'. See also section 11.

Dr. Gearóid Mac Niocaill continued to work on the translation and annotations of Vol.I of Seán Mac Airt's edition of the Annals of Ulster. An article entitled 'Jetsam, treasure trove and the lord's share in medieval Ireland' was accepted for publication in The Irish Jurist VI. In September 1971 Dr. Mac Niocaill resigned his post as Assistant Professor to take up an appointment as Lecturer in the Department of History at University College, Galway. See also section 11.

Mr. Fergus Kelly completed preparation on his edition of Audacht Mórind and the material has been sent to press. An edition of a poem in praise of Colum Cille was accepted for the next volume of Ériu. See also sections 10 and 11.

Tomás Ó Cathasaigh continued to work on early Irish Origin Legends. A short study of the legends of Cormac Mac Airt (including an edition and translation of one of them) was accepted for publication by the School. He assisted in the work of listing the contents of uncatalogued manuscripts in the National Library. Some work has been done on T. F. O'Rahilly's papers on Celtic mythology. See also sections 5, 6, 10 and 11.

Mrs. Nessa Doran completed preparation of Fasc.III of A Catalogue of Irish MSS. in the National Library of Ireland and corrected first and revised proofs of medical manuscripts in A Catalogue of Irish MSS. in King's Inns Library with Pádraig de Brún. See also section 10.

Mrs. Anne O'Sullivan checked first proofs of Professor Binchy's edition of Irish law texts with the following manuscripts:- Rawl. B 506; Rawl. B 487; E 3.5; Harl. 432. A transcription of the unpublished section of the Book of Leinster is in progress. Pages 311-341 have been transcribed and pp.311-322 rechecked with the manuscript. See also section 11.

Professor Proinsias Mac Cana, as General Editor of the Medieval and Modern Welsh Series, read the revised proofs of Mrs. Rachel Bromwich's edition of Armes Prydein.

Miss Mary Herbert worked on an edition of the collection of poetry in the manuscript Laud 615, together with examination of its relationship with other Colum Cille material. She has also been studying prophetic poetry in Irish, with specific reference to items on this theme in the above collection, and vaticinatory material generally, and hopes to study further the parallels between such material in Irish and Welsh. She worked on the preparation of an index of contents of uncatalogued manuscripts in the National Library. The following articles have been accepted for publication:- (i) 'The provenance of the manuscript Laud Misc. 615' (with Mrs. Anne O'Sullivan) for Celtica; (ii) 'Some Irish Prognostications' for Éigse. See also section 10.

Mr. Ronald Black studied Early Modern Irish material (chiefly verse) of Scottish provenance from manuscript sources in both Ireland and Scotland. While preparing an edition of the poem Saoth liom do chor, a Cholla he has amassed sufficient biographical material on its subject (Colla Ciotach Mac Gilleasbuig) for a separate study. He commenced an examination of the work of the Ó Muirgheasáin poets and worked on an investigation of some of the early evidence for the development of Scottish Gaelic. Some twentieth century texts were excerpted for the Historical Dictionary of Scottish Gaelic. He assisted in cataloguing some of the Irish manuscripts in the National Library. See also sections 10 and 11.

Dr. Arndt Wigger's work was concentrated on the following aspects of Modern Irish:- (i) The verbal system of Connemara Irish - a phonological analysis of the verbal forms on the background of an examination of the syntactic categories expressed in the verb (being part of a transformational grammar of the dialect). An article on this subject entitled 'Preliminaries to a generative phonology of the Modern Irish verb' has been accepted for publication in Ériu 23; (ii) Dialect usage concerning word order - a study of various re-ordering processes applied to complex sentences, seen as phenomena of 'linguistic performance'. A paper (in German) entitled 'Grammatik und Sprachverwendung in der Satzordnung des Neuirischen' was sent as a contribution to the forthcoming Festschrift Wilhelm Giese (Hamburg 1972); (iii) Comparative phonology of Irish dialects - a survey of the rules which derive the sound and form systems of individual dialects from a general underlying system (in collaboration with Mícheál Ó Siadhail, T.C.D.). See also sections 5 and 10.

Mr. John Shaw continued research on his doctoral dissertation concerning Old Irish verbal nouns and their relation to Indo-European stem-formation and the verbal system in Indo-European.

Mr. John Cullen continued research on a transformational analysis of some aspects of modern Irish syntax. He also prepared an article on the treatment of intervocalic \*j in Old Irish which has been accepted for publication in Ériu 23.

Miss Luce Diez has been learning Old and Modern Irish with a view to preparing a doctoral thesis on the subject of 'Celts and Germans'. She spent a month in the Connemara Gaeltacht.

Damien Ó Muirí was engaged on a study of the syntax of the Irish of Gaoth Dobhair, Co. Donegal. The work is to be divided into simple and complex sentence patterns. The object of the work is to provide a scientific description of the syntactic structure of the dialect. He spent a month at Middletown, Doire Beag, Co. Donegal doing field research. The material collected during his stay has been provisionally edited and submitted to Professor Greene who supervised the work.



Pádraig Breatnach collected material for a study of bardic poetry concerning the Battle of Kinsale and its political and social aftermath. The scope of his study has extended to include bardic poetry of the first half of the seventeenth century having a bearing on the theme. He proposes to identify characteristics and developments in the form and subject matter of such poetry. He worked on the preparation of an edition of a long poem on the death of Aodh Ruadh Ó Domhnaill.

Máire Ní Bharáin (Uí Mhaicín) worked on a poem on Cath Maige Tadurn from the Book of Uí Maine.

Dr. J. C. D. Marshall worked on medieval Latin vision literature in general and with the Vision of Tundal in particular. A systematic study of the differences between the Vision of Tundal and other works of similar character has led to the writing of 'Three Problems in the Vision of Tundal' which is to be submitted for publication. He examined and collated manuscripts of the Vision of Tundal with a view to writing a new critical edition. He studied Old Irish at Trinity College, Dublin with Professor E. G. Quin.

Dr. Cecile O'Rahilly continued preparation of an edition of Recension I of Táin Bó Cuailnge. She worked on T. F. O'Rahilly's lexicographical notes and wrote five notes on passages or words in Recension I of Táin Bó Cuailnge which have been accepted for publication in Celtica X. See also section 11.

M. Louis Paul Nemo continued to work on the Historical Dictionary of Breton. See also section 11.

Dr. Ludwig Bieler continued to act as General Editor of Scriptores Latini Hiberniae. He read revised proofs of I. P. Sheldon-Williams's edition of Iohannis Scotti Eriugena Periphyseon Liber II. Preparation of Liber III of this work is completed.

Mr. I. P. Sheldon-Williams read revised proofs of his edition of Iohannis Scotti Eriugena Periphyseon Liber II. Preparation of Periphyseon Liber III is now complete.

Mr. Brynley Roberts's edition of Brut y Brenhinedd, Volume V of the Medieval and Modern Welsh Series was published during the year.

Mrs. Rachel Bromwich read the revised proofs of her translation of Sir Ifor Williams's edition of Armes Prydein which is to be published as Volume VI of the Medieval and Modern Welsh Series.

Rev. Fergal Mac Raghnaill, O.F.M. prepared an edition of Ó hEóghasa's Teagasc Críostuidhe which was sent to press during the year under review.

Rev. Martin McNamara, M.S.C. completed the preparation of The Apocrypha in the Irish Church and the material was sent to press in March 1972.

### 3. STATUTORY PUBLIC LECTURE

A public lecture entitled 'The Oldest Irish Stories' was delivered by Professor Myles Dillon in Trinity College, Dublin, on 3 December 1971.

### 4. SEMINARS

Professor David Greene held a weekly seminar on *Saltair na Rann* in Michaelmas term, 1971 and Trinity term, 1972.

Professor Brian Ó Cuív held a weekly class on manuscript reading and textual editing in the Trinity term, 1971 and in the Hilary term, 1972.

Professor James Carney held a weekly seminar on Old Irish from October to December 1971 and January to February 1972.

Professor Arwyn Watkins held a weekly seminar on modern spoken Welsh from October to December 1971.

### 5. SYMPOSIUM

On March 27-28 1972 a symposium was held for university and college staffs and research workers. The following papers were read:-

Myles Dillon: The consecration of Irish kings.

Tomás Ó Cathasaigh: The king as hero; tales of Cormac mac Airt.

Bruce Boling: Some problems of verb structure in Old Irish.

Dáithí Ó hUaithne: Stair an chaoluithe sa tSean Ghaeilge.



Arndt Wigger: Competence and performance in modern Irish word-order.

Brian Ó Cuív: Céad bliain d'fhilíocht na mbard.

#### 6. MANUSCRIPT CATALOGUING

Work on the indexing of the contents of the Irish manuscripts in the National Library of Ireland continued under the direction of Professor Brian Ó Cuív. Three of the School's scholars and two extern workers took part. A further hundred manuscripts were indexed during the year.

#### 7. LEXICOGRAPHICAL AND LINGUISTIC ARCHIVES

Work continued on the excerpts for the Dictionary of Early Modern Irish. Professor Pádraig Ó Súilleabháin, O.F.M., has indexed Plunkett's Dictionary to the end of the letter A.

#### 8. DUANAIRE NA HARDTEISTIMEIREACHTA

As a result of the consultations with officers of the Department of Education referred to in this section of last year's report, the School undertook to provide edited texts of a number of Irish poems for inclusion in an anthology of Irish verse planned in connection with the Department's Leaving Certificate course. Professor Brian Ó Cuív prepared editions of poems in syllabic metres and Pádraig de Brún prepared editions of poems from the seventeenth to nineteenth centuries. An agreement was made with the Irish Educational Publishers Association whereby the latter undertook to acknowledge copyright of these editions and to pay a nominal fee for their use.

#### 9. CO-OPERATION WITH THE DEPARTMENT OF FINANCE

It was reported last year that the School had undertaken the preparation of a volume of documents on the Irish language for publication by the Department of Finance. During the year Professor Ó Cuív did some further work on the examination and selection of material for publication.

## 10. EXTERNAL ACTIVITIES

The Fourth International Congress of Celtic Studies held at Rennes in July 1971 was attended by the following members of the Institute:- Professors Brian Ó Cuív, David Greene, James Carney; Mrs. Nessa Doran, Mrs. Anne O'Sullivan, Mr. Fergus Kelly, Mr. Ronald Black, Miss Mary Herbert, Mr. Rolf Baumgarten and Mr. John Cullen.

Professor David Greene delivered the Best Memorial Lecture on 'R. I. Best and the development of Celtic Studies' in the National Gallery in May 1971.

Professor Myles Dillon accepted an invitation to the International Sanskrit Conference at New Delhi in March 1971. He read a paper on 'Sanskrit and Irish', and presided at one of the section meetings. After the Conference he delivered lectures at Allahabad, Calcutta, Madras, Jaipur and Chandigarh. The Bergin Memorial Lecture on 'Celt and Hindu' was delivered by him at University College, Dublin, in March 1972. He lectured at the Harvard Summer School in July - August 1971.

Professor James Carney lectured on 'The remote origins of amhrán' one of a series of Seán Ó Riada Memorial Lectures, at University College, Cork, on 3 February 1972.

Tomás Ó Cathasaigh lectured on Irish mythology to the Dublin Summer School in August 1971.

## 11. PUBLICATIONS

### (a) Books published by the Institute:

Brut y Brenhinedd. Edited by Brynley Roberts.  
pp.lxiv + 118. Price £1.05. Published August 1971.

Four Latin Lives of St. Patrick. Scriptores Latini Hiberniae, Vol.VIII.  
Edited by Ludwig Bieler. pp.xi + 266. Price £3.15. Published August 1971.

Celtica, Vol.IX. Edited by Myles Dillon.  
pp.345. Price £3.00. Published August 1971.

Caithréim Collaig. Mediaeval and Modern Irish Series, Vol.XXIV.  
Edited by Kathleen Mulchrone. pp.xvii + 103. Price 75p.  
Published August 1971.

Nua-Dhuanaire, Cuid I. Edited by P. de Brún, B. Ó Buschalla, and T. Ó Concheanainn. pp.x + 186. Price £1.50. Published January 1972.

(b) Books published outside the Institute:

Myles Dillon:

There was a King in Ireland. Published by the University of Texas Press, November 1971.

Brian Ó Cuív:

Éigse XIV, Parts I and II. Edited by Brian Ó Cuív. Published by the National University of Ireland.

David Greene:

Ériu XXII. Edited by David Greene. Published by the Royal Irish Academy, 1971.

Pádraig de Brún:

Filíocht Sheáin Uí Bhraonáin. Cló Bhréanainn, Baile Átha Cliath, 1972.

Mrs. Anne O'Sullivan (with Wm. O'Sullivan):

Introduction to Edward Lhuyd's Archaeologia Britannica. Published by Irish University Press, Shannon, 1971.

Roparz Hemon:

Historical Dictionary of Breton, Rann XVIII. (Klanv - Korfigellus). Published Etienne, Paris, 1971. pp.1701-1800.

(c) Contributions to periodicals and other publications:

David Greene:

The Irish war-cry. Ériu XXII, 167-173.

Varia. 1. Periods of time. 2. Ir. úathad, óthad; w. othid. Ériu XXII, 176-180.

Linguistic considerations in the dating of early Welsh verse. Studia Celtica VI, 1-11.

The responsive in Irish and Welsh. Indo-Celtica, 59-72.

D. A. Binchy:

An Archaic Legal Poem. Celtica IX, 152-168.

Varia Hibernica. (i) The so-called 'rhetorics' of Irish saga; (ii) Substantival dvanda-compounds in Irish. Indo-Celtica, 29-41.

Myles Dillon:

Correction to Celtica VIII. Celtica IX, 134.

Myles Dillon:

- Irish Púirín "Hen-House". Celtica IX, 190.  
 Irish Dérgaid 'Spreads (Coverings), Makes a Bed'. ibid., 205-9.  
 Reviews of publications. ibid., 333-41.

Brian Ó Cuív:

- Ionmhain an triúr théid san luíng. Celtica IX, 191-199.  
 A Penitent's Prayer. Éigse XIV, 17-26.  
 The Junction Consonants in atlochur and in Comparable Verbal Forms. ibid., 59-73.  
 Mael Ísu Ua Broicháin's Prayer to Saint Michael. ibid., 74.  
 An Appeal on Behalf of the Profession of Poetry. ibid., 87-106.  
 Reviews of publications. ibid., 75-80, 163-8.  
 Some declensional patterns in Modern Irish. Indo-Celtica (Gedächtnisschrift für Alf Sommerfelt), 94-110.  
 The Irish Language and its Literature. No.15 in the series Documents on Ireland, issued by the Department of Foreign Affairs.

James Carney:

- Three Old Irish Accentual Poems. Ériu XXII, 23-50.

Pádraig Ó Súilleabháin, O.F.M.:

- Seanmóir ar uimhir bheag na bhPírean. Éigse XIV, 105-20.  
 Varia. ibid., 121-6.  
 Smaointe beatha Chríost. Celtica IX, 210-11.  
 Thomas Fitzsimons and the 'Primer of the B.V.M.' Bréifne, Vol.IV No.13, 92-3.  
 A Humorous letter of Mark O'Keeffe. The Past 9, 71-2.

Pádraig de Brún:

- Lament for Edmond Lynan attributed to Aogán Ó Rathaille edited as Appendix 4 (pp.54-65) of J. A. Gaughan, The Lynan Family (Kamac, Dublin, 1972).  
Graobhacsaillleadh seanchais Chloinne Piarais edited and translated as an Appendix (pp.27-30) to J. H. Pierse, 'The origin of the Pierse family of County Kerry', Journal of the Kerry Archaeological and Historical Society No.5 (1972), 14-32.  
 Sir Richard Cox's description of Kerry, 1687. ibid., 33-45.

Mrs. Anne O'Sullivan:

Tadhg O'Daly and Sir George Carew. Éigse XIV, 27-38.

Three notes on Laud Misc. 610. Celtica IX, 133-151.

Fergus Kelly:

Old Irish ad-claid; claideb. Ériu XXII, 190-196.

Tomás Ó Cathasaigh:

The origin and early history of the Déisi. The Old Waterford Society Journal II, 74-8.

Gearóid Mac Niocaill:

The Second Recension of the Evernew Tongue. (With Úna Nic Énri).  
Celtica IX, 1-60.

Bartholomaei Anglici de Proprietatibus Rerum Liber Octavus.  
ibid., 266-315.

Dr. Cecile O'Rahilly:

Notes on Conjunctions. Celtica IX, 113-133.

On the exclamatory use of the Verbal Noun. ibid., 213.

Lexicographical Notes. Éigse XIV, 54-58.

Ronald Black:

Review of Matheson, The Blind Harper. Studia Hibernica XI, 194-7.

III - Report of the Governing Board of the School of Theoretical Physics  
adopted at its meeting on 20 July 1972.

1. ACADEMIC STAFF AND SCHOLARS

Emeritus Professors:

Cornelius Lanczos; John L. Synge, from 24 March 1972.

Senior Professors:

Rev. James R. McConnell, Director to 9 January 1972; John L. Synge, retired 23 March 1972; Lochlainn S. Ó Raifeartaigh, appointed Director for three years from 10 January 1972.

Visiting Professors:

Michael Carroll (October 1971 - September 1972); Max Dresden (October 1971); I. Kovacs (January-February 1972); Nandor Balazs (28 February - 3 March 1972).

Assistant Professors:

Alexander I. Solomon (to 30 September 1971); Seán Dineen (appointed 1 October 1971).

Research Associates:

D. Judge, P. S. Florides, Rev. C. P. Ryan (October 1969 - September 1972); Rev. D. McCrea (June 1969 - September 1972); B. K. P. Scaife (January 1970 - September 1972); P. D. McCormack (October 1970 - September 1972); A. I. Solomon (January 1972 - September 1975).

Scholars:

P. Yodzis; S. Banerji; P. de Baenst (without stipend); J. M. Golden (left September 1971); S. Dineen (left September 1971); M. Connolly (left September 1971); T. Yoshimura; J. Gomatam (appointed October 1971); P. Hogan (appointed October 1971); S. Browne (appointed October 1971 - without stipend); D. Tchraïkian (appointed October 1971).

Secretary and Assistant Librarian:

Evelyn R. Wills.

2. GENERAL

The School was moved from 64 Merrion Square to 10 Burlington Road on 1 December 1971.

The Dewey System was introduced in the Library during the year.

A valuable gift of journals and books from the estate of the late Professor F. E. Hackett was made to the Library by Miss Nor Murnaghan in April 1971.

### 3. STUDY AND RESEARCH

Professor Lanczos continued his research concerning the quadratic action principle of relativity. The proof could be given that a high frequency plateau can be harmonised with the existence of a genuine (positive definite) Riemannian geometry, although the superposition metric becomes Minkowskian. Moreover, the process of averaging cancels out general covariance. The "free vector" of infinitesimal fields - usually caused by the freedom of the choice of coordinates - is no longer free but becomes subjected to the wave equation and the Lorentz condition. It can thus be identified with the electromagnetic vector potential. However, this investigation does not go beyond the linear approximation. This work has been accepted for publication in Foundations of Physics.

Professor Synge's research for the year is summarised in the titles of papers listed elsewhere in this report as already published or in course of publication. Some of this work was done in collaboration with Dr. Florides, Dr. Yodzis and Mr. P. A. Hogan. The main topic is the geometry of relativity, with some excursions into some geometrical aspects of quantum mechanics. Special mention may be made of the paper (Hogan and Synge) in which it is shown how, in general relativity, a massive sphere may be set in rotation, a result impossible in Newtonian mechanics on account of the conservation of angular momentum. In another paper Newtonian gravitation is exhibited as a field theory, a concept rejected by Maxwell on account of negative energy-density. In addition to this work, Professor Synge discussed with Professor M. M. Carroll the problem of finding the maximum number of possible collisions of elastic particles, and succeeded in proving Carroll's conjecture that this number is  $\frac{1}{2}n(n-1)$  for  $n$  particles in certain special cases, Newtonian and relativistic.

The major part of Dr. Yodzis's research was concerned with the global structure of spacetime. He obtained a general equation for the evolution of the "spatial" volume of closed universes, which equation



indicates that the "zero volume" singularity encountered in closed Robertson-Walker universes might be avoided if the initial state of the universe were sufficiently turbulent. In another study of global spacetime structure, he constructed spacetime manifolds in which "changes of topology" take place. He showed that in these spacetimes stable causality and positive energy density can be maintained; further studies are aimed at determining whether geodesic completeness can hold as well. Dr. Yodzis also completed earlier work on the asymptotic behaviour of electromagnetic form factors (in the context of frame-dependent cutoff quantum field theory), showed that some of the large red shifts associated with quasars could be simply Doppler shifts due to large peculiar velocities (working from observational evidence due to H. Arp), and collaborated with Professor Synge in a reformulation of quantum mechanics in terms of motions (in the sense of differential geometry) of Hilbert space. He commenced studies of the problem of quantization of spacetime.

Dr. Banerji found a method for calculating the space-time metric inside a collapsing or expanding sphere, and has submitted a paper on this method to General Relativity and Gravitation. He found a method for determining Schwarzschild coordinates in the gravitational field of a star by idealized experiments, and submitted a paper on this work to Nature. He is now studying the hydrodynamical equations arising out of relativistic theories of gravitation involving a scalar field.

Mr. Hogan constructed a model of a spherical distribution of charged matter using Professor Synge's new approximation technique in order to study the physical interpretation of the constants appearing in the Reissner-Nordstrom solution of the Einstein-Maxwell field equations; he also studied the escape of neutrinos from within a thick spherical shell and in particular from within Einstein's spherical cluster of gravitating masses.

Dr. McCrea extended to the third dimension his previous work on the gravitational field of a rotating sphere, using the method of Synge (Proceedings Royal Irish Academy 1970); a metric was calculated both

inside and outside the sphere together with an energy tensor such that the equations of motion are satisfied to the order of approximation mentioned. The exterior metric was compared to that of Lense and Thirring, and the exact metric of Kerr. It was found that by modifying the stresses in the spherical body, it was possible to produce a metric which agrees with that of Kerr, to the approximation considered. The results were communicated to the Royal Irish Academy by Professor Synge. Dr. McCrea also cooperated with Mr. Hogan in the application of Synge's method to the motion of several bodies, charged and uncharged.

Dr. Florides considered a rotating sphere as a possible source of the Kerr metric, and whether the Kerr metric might be the field of a rotating perfect fluid.

Professor McConnell studied the characters of the unitary and orthogonal groups, developing earlier investigations of Murnaghan and Newell. He continued to work with Dr. D. J. Simms on the preparation of a textbook on algebra.

Professor Ó Raifeartaigh developed some earlier work with U. H. Niederer on Mackey-Wigner and covariant wave functions; this work is approaching final form. Professor Ó Raifeartaigh worked also with A. P. Balachandran (Syracuse) and J. Nilsson (Göteborg) on Mackey states for scattering of relativistic particles with spin. This work was commenced in Göteborg in July 1971 and recently completed. In collaboration with Drs. Gomata and Tehrakian, Professor Ó Raifeartaigh also worked on the calculation of Wigner angles.

Dr. Golden read papers on pion-pion scattering and attempted to solve a number of research problems, making use of the computer at the Observatory at Dunsink. He also studied numerical analysis. Recently he has been studying the effect of the presence of absorbing nuclei on the diffusion coefficient of small ions in air.

Dr. Gomata's research was on the following topics: (1) The role of Noether's theorem in classical Hamiltonian dynamics. (2) A simple method of calculating Wigner angles with applications to crossing symmetry in high energy scattering theory. (3) A new solvable model

describing species in ecological interaction with applications to Population Dynamics.

Dr. Tchrakian studied certain aspects of partial wave analysis and crossing relations for spin amplitudes, in collaboration with Professor Ó Raifeartaigh. They also studied Wigner rotations in detail, with special view to applications, particularly to crossing. These results clarify and sharpen considerably the existing formalism.

Dr. Yoshimura considered the possibility of generalizing composite particles in quantum field theory. He considered the cases of (1) a composite particle consisting of one particle; (2) the Gedipal particle,  $\Omega$ , comparing his work with that of Jouvét et al.; (3) an anti-composite particle; and (4) cross composite particles.

The main subject investigated by Dr. Ryan was the light cone behaviour of configuration space matrix elements and the relation of this behaviour to the asymptotic behaviour of momentum space matrix elements. He also studied aspects of dilatation invariance in particle physics and a problem in Lagrangian-Hamiltonian mechanics.

Dr. Judge continued his work on representations of the quasi-canonical commutation relations, and also considered the problem, arising in physical chemistry, of the potential of two coalescing dielectric spheres with central charges.

Professor Carroll's research was in the following areas: (1) Continuum mechanics: universal states of stress in finitely deformed elastic bodies, mechanical and thermal response of ductile porous materials, elastic shells; (2) Nonlinear optics: waves of constant amplitude; (3) Particle mechanics: elastic collisions.

Professor Dineen completed a study of topological vector space properties of holomorphic functions defined on an infinite dimensional locally convex space and commenced studying and working on applications of sheaf theory to infinite dimensional holomorphy.

Dr. Corneely continued to work on the classification of states of two electron systems using the  $R_4$  symmetry group, and on the asymptotic form of the coupled differential equations which arise in collision problems.

Professor Solomon continued his work on the application of the theory of Lie algebras to quantum many body theory, with special reference to problems of superfluidity and superconductivity. He examined models for coupled superfluids and superconductors, for which the appropriate groups are  $SO(3,2)$  and  $SO(5)$  respectively, and the related tunneling phenomena.

Professor Scaife continued his work on a book on physics of dielectrics. He accepted the invitation of the Royal Irish Academy to edit a Festschrift in honour of Professor Lanczos.

Dr. McCormack continued to consider the transport properties of a gas of rotationally excited molecules, from the viewpoint of classical kinetic theory. And also the molecular dynamics of the liquid (vapour phase transition).

#### 4. SEMINARS AND REVIEW LECTURES

Review and Seminar lectures were held throughout the year, and as in previous years they were attended by members of staff and students from Trinity College, Dublin, University College, Dublin and St. Patrick's College, Maynooth, as well as by members of the School of Cosmic Physics.

The following Seminars were given:

Professor N. L. Balazs (Stony Brook): Quantum oscillations in Fermi-gases.

Professor P. K. Carroll (U.C.D.): Rydberg states of the  $N_2$  molecule.

Dr. R. Chanda (U.C.D.): Phenomena of electron colliding beams.

Professor M. Dresden (Stony Brook): Non-linear realisations of the Poincaré group.

The divergence problem in  
statistical mechanics.

Dr. P. S. Florides: A rotating sphere as a possible source of the Kerr metric.

Dr. J. M. Golden: Non-linear trajectories and the Veneziano model.

Dr. J. Gomatam: Indefinite metric and physical models.

Application of continuous representation theory to  
quantum optics.

Professor I. Kovacs (Polytechnic Inst., Budapest): Centrifugal distortions and multiplet structure (2).

Dr. E. Lalor (U.C.D.): Holography.

Professor C. Lanczos: A simplified approach to Noether's theorem (2).

Professor J. R. McConnell: Reduction of  $GL(7)$  under the exceptional group.

Professor R. F. O'Connell (Louisiana State, Baton Rouge): Present status of the theory of the relativity-gyroscope experiment.

Dr. R. Penrose (Birkbeck Coll., London): Geometry of impulsive gravitational waves.

Dr. J. C. Polkinghorne (Cambridge): Deep inelastic scattering.

Dr. D. J. Simms (T.C.D.): Lifting projective representations of Lie groups.

Professor A. I. Solomon: Group theory of coupled superfluids.

Professor T. D. Spearman (T.C.D.): Ambiguities in phase-shift analysis.

Professor J. P. Wesley (Missouri): A flat space-time theory of gravitation.

Dr. P. Yodzis: Cobordism, Lorentz structures and gravitational collapse.

The following Review Lectures were given:

Professor M. Carroll (Berkeley): Continuum mechanics.

Professor N. L. Balazs (Stony Brook): Einstein and Poincaré.

Dr. M. Conneely: Electron-atom collisions.

Dr. P. Yodzis: Relativistic invariance without dogma.

Professor J. L. Synge: Essentials of general relativity.

Dr. S. Dineen: Several complex variables.

Dr. S. Banerji: Copenhagen Conference: Gravitational collapse; experimental tests of general relativity.

Dr. P. Yodzis: Copenhagen Conference: Space-time structure; gravitational radiation.

A course of six lectures on "Diatomic molecules" was given in University College, Dublin, by Professor Kovacs.

## 5. LECTURES FOR UNIVERSITY STUDENTS

The School continued to provide lectures suitable for university students in mathematics and physics.

6. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on "Population dynamics", by Professor Max Dresden, on 29 October 1971.

7. VISITING PROFESSORS

W. R. Davis (North Carolina State University) 8-16 April 1971.

J. P. Wesley (University of Missouri) 5 May 1971.

R. F. O'Connell (Louisiana State University, Baton Rouge) June 1971.

A. Das (Simon Fraser University, British Columbia) June 1971.

W. Israel (University of Alberta, Edmonton) July 1971.

Professor Horing (New York) 10-11 August 1971.

R. Penrose (Birkbeck College, London) 26 November 1971.

J. C. Polkinghorne (Cambridge) 8 December 1971.

N. L. Balazs (State University of New York, Stony Brook) 13-17 December 1971.

8. SYMPOSIA

Mathematical Symposia were held on 5-6 April 1971, 20-21 December 1971 and 23-24 March 1972. The attendances were 43, 54 and 55 respectively; these included Professors, Lecturers and Graduate Students from the several Irish universities.

In addition to the short communications (previews), the following lectures were delivered:

5-6 April 1971:

Dr. S. Dineen: Bounding sets of Banach space.

Dr. R. F. Smyth (T.C.D.): Riesz vectors in Banach algebras.

Dr. J. T. Lewis (Oxford): Brownian motion in quantum mechanics.

Dr. T. Murphy (Essex): On the tensor system of a semi-simple Lie algebra.

Dr. J. J. Miller (T.C.D.): Von Neumann polynomials and weak stability.

Mr. C. Nash (Cambridge): Parton model of high energy scattering.



20-21 December 1971:

- Dr. M. L. Newell (U.C.G.): Some group-theoretic results for Lie algebras.  
Mr. D. W. Arthur (T.C.D.): Interval arithmetic and polynomial zeroes.  
Dr. E. MacAogain (Warwick): Representations of the symmetric group.  
Dr. S. G. Hoggar (Glasgow): The invention and use of topology.  
Prof. A. I. Solomon (Open Univ.): Group theory model of superfluid tunneling.

23-24 March 1972:

- Dr. T. J. Laffey (U.C.D.): Groups versus rings.  
Mr. M. R. F. Smyth (Edinburgh): The polar mapping theorem and its application to operator theory.  
Mr. G. P. Shannon (N.U.U.): Strictly singular and strictly cosingular operators on topological vector spaces.  
Dr. P. Dolan (Imperial Coll.): Fibre bundles and general relativity.  
Dr. J. T. Lewis (Oxford): Representations of the canonical computation relations.  
Dr. F. Holland (U.C.C.): Partially isometric Hankel operators.

9. EXTERNAL ACTIVITIES

Professor Lenczos gave the following lectures: "Noether's principle", at the New University of Ulster (1 May 1971); "Physical law and understanding", at the University of Glasgow (20 October 1971); "Universal theory of algebraic systems", at the University of Glasgow (21 October 1971); "Physical law and understanding", at University College, Dublin (2 November 1971); "Science as a form of art", at University College, Dublin (3 February 1972); "Theory and experiment", at a Meeting of the Irish Branch, Institute of Physics, at Carrickmacross (26 March 1972).

He also attended, by invitation, the presentation of the Paul Ehrlich Prize at the Johann Wolfgang Goethe University, to Drs. Burkill and Waldenheim, on 14 March 1972.

Professor Synge was awarded the Boyle Medal of the Royal Dublin Society, and delivered the Boyle Medal lecture entitled "Geometry and Physics", on 28 March 1972.

Professor McConnell lectured on "Use of Lie groups in theoretical physics" at Manchester University, and also visited the Physics Department



of Liverpool University on 28 April 1971. He attended the Third International Conference "De la Physique Théorique à la Biologie" at Versailles, 20 to 26 June 1971. He visited the Central Research Institute for Physics at Budapest, and the Universities of Debrecen and Szeged in September-October 1971, and gave a lecture at Budapest on "Graphical methods in weight diagrams" on 8 October. He attended a meeting of the Committee of the Royal Society European Exchange Programme at Rome on 25 October 1971. On retiring from the Secretaryship of the Royal Irish Academy on 16 March 1972 he was appointed a Vice-President.

Professor Ó Raifeartaigh attended the Conference on Duality and Symmetry in Hadron Physics at Tel-Aviv, 5-7 April 1971. He was invited to the Eleventh Cracow School of Theoretical Physics, at Zakopane, Poland, from 14-18 June 1971. He visited the University of Warsaw from 21-25 June and the Tekniska Högskola, Göteborg, Sweden from 5 July to 13 August 1971 and lectured in both institutions on "Mackey-Wigner and covariant wave-functions". He attended the Irish Physics Students' Conference, Cork, 2-3 January 1972, where he gave a lecture entitled "The World of Particle Physics", and he attended the Rutherford High Energy Conference, Didcot, 4-5 January 1972. He gave two lectures at the New University of Ulster, Coleraine, on 7 February entitled "The Marriage of Relativity and Quantum Mechanics", and "Newton's Equations and the Galilean Group".

Professor Solomon attended the Summer Institute of Theoretical Physics at the University of Colorado, Boulder, Colorado, in July 1971; he also lectured in July 1971 on "Group theory of Superfluidity" at Brooklyn Polytechnic, New York, and at the University of Alberta, Edmonton.

Dr. McGerwick lectured on "The liquid-vapor phase transition and surface tension" at the Conference on Statistical Mechanics, I.U.P.A.P., University of Chicago, and on "Combustible vortex rings" at the Seminar of the Fluid Mechanics Faculty, at the University of Utah, in April 1971. He gave seminars in February 1972 at Simon

Fraser University, and at the University of Utah. He was appointed Adjunct Professor of Applied Mechanics at the University of Utah in March 1972. He was awarded an Sc.D. in Dublin University in May 1971.

Dr. Ryan was Visiting Scientist at the Theoretical Physics Institute, University of Alberta (Edmonton) for July and August 1971, and attended the Meeting of the Division of Particle and Fields of the American Physical Society at the University of Rochester from 30 August to 1 September. During September he gave seminars on "Asymptotic regions in momentum space and the light cone in configuration space" at the University of Rochester, and at the Lawrence Radiation Laboratory, University of California. He also attended the High Energy Physics Meeting at the Rutherford High Energy Laboratory, Didcot, Berkshire from 5 to 7 January 1972.

Drs. Florides, Yodzis, Banerji and McCrea attended the International Conference on General Relativity at Copenhagen in July 1971; Dr. Florides gave a talk there on "A rotating sphere as a possible source of the Kerr metric". Drs. Yodzis and McCrea attended the Colloquium on General Relativity, in Brussels, 20-22 December where Dr. Yodzis lectured on "Lorentz cobordism". Dr. Yodzis gave an invited seminar at King's College, London on 26 January 1972 on "Some properties of Morse singularities". Dr. Florides gave two lectures in Athens to the Greek Mathematical Society in September 1971 on "Rotating bodies in general relativity".

Mr. Hogan attended the Rome Relativity Conference, 7-12 February 1972.

Professor Scaife lectured at a meeting of the Dielectrics Discussion Group at Bedford College (London) on 8 April 1971; and at the Department of Physics of the New University of Ulster, Coleraine, on "Motion of space charge in a dielectric medium" in May 1971.

Professor Dinneen attended the Conference on Numerical Range, at Aberdeen from 5 to 12 July 1971. From 16 to 23 July he gave three lectures at the Royal Irish Academy Summer School at University College, Cork, on "Function theory". He gave invited lectures on 22 October at

the University of Swansea, and on 16 February 1972 at Queen's University Belfast. He accepted an invitation to Nancy and Paris from the University of Nancy for 22 to 31 March 1972, and during his visit gave a conference at Seminaire Lelong, Paris, and at the University of Nancy.

Professor Carroll visited University College, Cork from 7 to 10 March 1972, and gave four lectures there on Continuum mechanics. He also lectured "On porous materials" at the University of Manchester Institute of Science and Technology on 20 March, and at the University of Nottingham on 22 March.

Dr. Yoshimura was on leave of absence from the School at the University of Essex from October 1971.

Dr. Conneely attended the Third National Atomic and Molecular Physics Conference at the University of York, 5-8 April 1971.

Dr. Golden attended the International Conference on Elementary Particle Physics in Amsterdam, 29 June to 6 July 1971.

#### 10. PUBLICATIONS

Items marked with an asterisk were recorded as in press in previous reports.

##### (1) Books:

Published:

- \* Complex permittivity. Edited by B. K. P. Scaife. English Universities Press, 1971.

L'Univers des nombres, a la decouverte des mathematiques.  
By C. Lanczos. Dunod, 1971. (Trans. of "Numbers without end",  
Oliver & Boyd, 1969.)

In the press:

- \* Volume on relativity, to mark the 75th birthday of J. L. Synge.  
Edited by L. Ó Ráifeartaigh. Clarendon Press, Oxford.

##### (2) Communications of the Dublin Institute for Advanced Studies, Ser. A (Physics):

Published:

- \* No.20. Weight diagrams. By J. R. McConnell. Price £1.50.  
pp.v + 164. Published 30 November 1971.

In the press:

- No.21. Quaternions, Lorentz transformations, and the Conway-Dirac-Eddington matrices. By J. L. Synge. Dedicated to the memory of A. W. Conway (1875-1950).

(3) Contributions to periodicals and other publications:

Published:

J. L. Synge:

- \* Fixed points for infinitesimal Poincaré transformations in Minkowskian space-time. London Math. Soc. Bull. 3 (1971), 163-66.

- \* A special class of solutions of the Schrödinger equation for a free particle. Foundations of Phys. 2 (1972), 35-40.

Geometrical approach to the Heisenberg uncertainty relation and its generalization. Proc. Roy. Soc. 325 A (1971), 151-56.

Relativity and reality. Review of L. Jánossy, Theory of relativity based on physical reality (Akad. Kiado, Budapest, 1971) and J. C. Graves, The conceptual foundations of contemporary relativity theory (M.I.T., Cambridge, Mass., and London, 1971). Nature 234 (1971), 274-75.

P. S. Florides & J. L. Synge:

- \* Coordinate conditions in Riemannian space for coordinates based on a subspace. Proc. Roy. Soc. 323 A (1971), 1-10.

P. S. Florides & R. Wingate:

- \* Rotating shells in general relativity. Bull. Soc. Math. Grèce 11 (1970), 172-230.

P. Yodzis:

- \* Some general relations in relativistic magnetohydrodynamics. Phys. Rev. 3D (1971), 2941-45.

P. A. Hogan:

- R The equations of motion of charged bodies in general relativity. Proc. R.I.A. 72A (1972), 35-50.

U. Niederer & L. Ó Raifeartaigh:

- \* Wave-equations and saturation of current algebra for  $I=\frac{1}{2}$ . Phys. Rev. 4D (1971), 1896-1908.

J. Golden:

- \* A generalized Veneziano model with non-linear trajectories. Nuovo Cim. Lett. 1 (1971), 893-98.

Nonlinear trajectories in a dual model: an integral representation. Nuovo Cim. Lett. 2 (1971), 173-76.

C. Ryan:

- \* Higher order effects in K-meson decays. Proc. Daresbury Study Week-and on K-decay, ed. by A. Donnachie & D. G. Sutherland. DNP/89, 1971.

C. Ryan:

- R* Hamiltonian formalism for general Lagrangian systems in an exceptional case. J. Mathl. Phys. 13 (1972), 283-85.
- R* Weak interactions of elementary particles. Science Progr. 60 (1972), 53.

R. Chanda & C. Ryan:

- R* Light cone expansions and form factors. Nuclear Phys. AQB (1972), 573-75.

S. Dineen:

- R* Fonctions analytiques dans les espaces vectoriels topologiques localement convexes. C. R. Acad. Sc. Paris 274 (1972), 544-46.
- R* Runge domains in Banach space. Proc. R.I.A. 71 A (1971), 85-89.

S. Dineen & A. Hirschowitz:

- \* Sur le théorème de Lévi-Schur. C. R. Acad. Sci. Paris 272 (1971), 1245-47.

P. McCormack:

- \* Molecular interaction and vortex core size. Phys. Lett. 35A (1971), 271-72.
- \* Combustible vortex rings. Proc. R.I.A. 71A (1971), 73-83.

Y. Takahashi:

- \* Some covariant identities and the generators of the Poincaré group. Proc. R.I.A. 71A (1971), 1-11.

In the press:

C. Lanczos:

Einstein's path from special to general relativity. Volume to mark 75th birthday of J. L. Synge. Ed. L. O'Raifeartaigh. Clarendon Press, Oxford.

- R* Vector potential and quadratic action. Foundations Phys.

J. L. Synge:

- R* Newtonian gravitational field theory. Il Nuovo Cim.
- \* The electrodynamic double helix. J. A. Wheeler Festschrift.
- \* Review of "The common scientist in the 17th century: A Study of the Dublin Philosophical Society, 1683-1708", Routledge & Kegan Paul, 1970. Hermathena.
- R* Geometry of dynamical null lines. Tensor.

P. A. Hogan & J. L. Synge:

- R* Model of a gravitating sphere set in motion by internal stress. General Relativity and Gravitation.

J. L. Synge & P. Yodzis:

Kinematics, angular momentum, and Eulerian dynamics in Hilbert space. Proc. R.I.A. R

P. S. Florides:

\* Rotating bodies in general relativity. Volume to mark 75th birthday of J. L. Synge. Ed. L. Ó Raifeartaigh. Clarendon Press, Oxford.

P. A. Hogan:

A note on the escape of neutrinos from within a thick spherical shell. Proc. R.I.A. R

D. McCrea:

Gravitational field of a uniformly rotating sphere in third approximation. Proc. R.I.A. R

P. Yodzis:

On the expansion of closed universes. J. Mathl. Phys. R

Lorentz cobordism. Commun. Math. Phys. R

$t^{-2}$  law for electromagnetic form factors. Phys. Rev. R

S. Banerji:

A method for calculating the space time metric inside a collapsing or expanding sphere. Proc. Internat. Conf. Grav. & Rel., Copenhagen 1971. R

J. R. McConnell:

Weight diagrams for the general linear group in five dimensions. Hungar. Phys. Acta. R

Reduction of representations of the general linear group using Lie algebras. S.I.A.M. Sympos. Ser.

\* Review of "Space through the ages", C. Lanczos, Academic Press, 1970. Phil. Studies.

U. Niederer & L. Ó Raifeartaigh:

\* Mackey-Wigner and covariant group representations. Proc. NATO Summer School, Istanbul, 1970.

S. Dineen:

Holomorphic functions on  $(c_0, X_b)$ -modules. Math. Ann. R

Convexité holomorphe en dimension infinie. Proc. Sem. Lelong. R

M. M. Carroll & P. M. Naghdi:

On the influence of the reference geometry on the response of elastic shells. Arch. Rat. Mech. Anal. R

M. Conneely & S. Ormonde:

\* Continuum processes in atomic nitrogen. Phys. Rev. A.

M. Conneely, L. Lipsky & M. Ahmed:

- \* Configuration mixings in two-electron systems. Proc. Seventh Internat. Conf. on Physics of Electronic & Atomic Collisions.

B. K. P. Scaife:

R Problems in dielectrics. Problems in Solid State. Ed. A. Jonscher & B. Ferrari. Pion Publns., London.

R On the macroscopic theory of dielectrics. Special Publication, Faraday Division, Chemical Society.

R On force effects and dielectric fluids. Festschrift for H. Fröhlich, Springer.

B. K. P. Scaife & T. Ambrose:

R On van der Waals interaction at long and short range. Proc. R.I.A.



IV - Annual Report of the Governing Board of the School of Cosmic Physics  
adopted at its meeting on 24th July 1972.

A. Astronomical Section

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Professor:

T. Kiang.

Visiting Professor:

T. C. Weekes (1971 June 15 - August 15).

Research Assistants:

I. Elliott; C. J. Butler.

Experimental Officer:

B. D. Jordan.

Research Associates:

Professor N. A. Porter, U.C.D.; Dr. M. Hecy, U.C.D. (from 1972 March 1); Dr. A. D. Andrews, Armagh Observatory (from 1972 March 1).

Technical and Clerical Staff:

Miss A. M. Callanan; Mr. R. P. Murphy; Mrs. A. Norris (née Downey).

Scholars:

M. V. Morris; P. B. Byrne; Dr. S. Flagemann (from 1971 October 16);  
A. D. Andrews (without stipend, to 1971 July 1).

Mr. P. B. Byrne worked at the Boyden Observatory, Bloemfontein, from May 3 to August 17, 1971. C. J. Butler and A. D. Andrews presented theses for the Ph.D. degree at the University of Dublin in 1971 and subsequently received the award of the degree.

The National Science Council appointment of C. J. Butler as Research Assistant continued throughout the year.

2. RESEARCH WORK

Solar Research: I. Elliott.

The Joyce-Loebl Autodensitometer equipment has been used for scanning a sequence of  $H\alpha$  filtergrams. Each frame produces 4500 density readings

on Punched paper tape. Scans of filtergrams in the red and blue wings of the  $H\alpha$  line make it possible to represent the density of light and the local velocity for each part of the chromosphere in the field of the filtergrams. The results have been plotted as contour diagrams and comparisons have been made with K-line data. A pilot program indicates that the power spectrum of the velocity field can be derived as a function of position in two dimensions. A full analysis has been deferred, awaiting a better means for handling the very large arrays of data.

A new analysis of the yearly sunspot numbers from 1700 to 1970 has been carried out by treating the sequence as a stochastic process and by estimating the power spectrum. The results show a principal maximum corresponding to a period of 11.05 years, with secondary maxima at 10.0, 95.0, and 55.5 years, the peaks being in the ratios 5 : 3 : 2 : 1. The method has also been applied to part of Schöve's series of sunspot numbers derived from historical records of auroral activity; a strong peak at 205 years has been found. The results agree well with a similar study recently carried out at Pulkova Observatory, Leningrad.

Photometry of Stars: P. A. Wayman, C. J. Butler, M. V. Norris.

Two pairs of ADH plates of the LMC I region were inspected with the blink microscope at Armagh Observatory to complete the search for variable stars in this region, 43 new suspected variables were found, bringing the total for the two regions LMC I and LMC II to 307. A publication giving co-ordinates and identification charts for these stars was prepared.

The publication of standard magnitudes from photoelectric and photographic measures in the UBV system of 546 stars in the three Magellanic Cloud regions represented by present material (SMC, LMC I, LMC II) was completed during the year.

Preparation for the measurement in the LMC I region by "Galaxy" machine has been undertaken, using, in part, measuring equipment at the Royal Greenwich Observatory. All known or suspected variables

in the LMC I region were identified and a routine was established for measurement on 96 ADH plates.

Ten long-period variables have been measured in the LMC II region. The variables fall into two distinct period groups ( $>500^d$ ,  $<200^d$ ). The second group appears from Gaposchkin's lists to have no counterpart in the SMC, and it is possible that they may have been below the threshold of detection. The mean absolute magnitude at maximum found for the members of this group was  $M_V = -3.25 \pm 0.14$   $M_B = -1.63 \pm 0.18$ . They appear to be the LMC counterparts of the galactic halo SRd variables or the galactic disk Mira variables.

An investigation of Sanduleak's cluster foreground to the LMC, using measures by Edinburgh's "Galaxy" machine has been extended to include additional calibration stars from a sequence by van Wijk. The reduction procedures are not yet completely re-run.

The study of short-period variables in the Magellanic Cloud cluster NGC 1466 has been virtually completed. Of the twenty-seven variables identified by Wesselink, satisfactory periods were found for ten. Nine are Bailey type ab with periods between 0.48 and 0.59 days while one is of type c with a period of 0.35 days. The period-amplitude diagram clearly indicates a metal-content similar to M3 and M5 and this similarity is also represented in the redward termination of the giant branch in the colour-magnitude diagram. The variables define a horizontal branch at  $V = 19.15 \pm 0.12$  and an instability strip from  $(B-V) = 0.17$  to  $0.41$ . The blue edge of this strip is interpreted, by the calculations of Iben and Huchra, as indicating a helium content near  $\gamma = 0.32$  and, using the same calculations, the mean mass is deduced to be 0.6 solar masses and the bolometric magnitude  $M_{bol} = +0.5$ . A distance-modulus for NGC 1466 of 18.65 follows.

The general pattern of short-period variables in a range of globular clusters has been studied in relation to the role played by core mass and the resulting number of variables in the fundamental and first harmonic instability regions.

Cepheid Variables: C. J. Butler.

The adoption of period-luminosity-colour relationships for the cepheid variables observed in the LMC II and SMC regions has led to an interpretation in terms of variation in chemical composition, using the theoretical results by Stobie. In particular, his results show that the blue edge of the cepheid instability strip in the period-colour diagram is sensitive to helium and heavy-element abundance. The observed limits for the cepheids in the Galaxy and the two Magellanic Clouds suggest that the He abundance is uniform but that the metal abundance in the LMC is below that of the Galaxy by a small factor and that of the SMC is below that of the Galaxy by a factor of about four.

Asteroids: T. Kiang.

The statistics of asteroids are strongly affected by factors of observational selection and an attempt has been made to formulate the problem rigorously amongst the permanently numbered asteroids. It is recognized that the central problem is the determination of the true, time-independent distribution-function of six parameters (five orbital elements and mean magnitude at opposition) from the corresponding observed distribution-function affected by a time-dependent selection-function. This last function is related to detection threshold and to observatory records, in conjunction with brightness and location in the sky.

The peculiarity in the distribution of perihelion angle  $\omega$ , known since 1966, has been shown to hold only when inclination, aphelion distance and eccentricity are large. This means that non-librating asteroids with orbits close to that of Jupiter survive only under very stringent conditions, and hence the general lack of such asteroids is almost certainly due to catapulting by Jupiter and not due to initial conditions. This conclusion lends support to the idea that it is the very lack of these non-librating asteroids that ensures the permanence of the librating asteroids of the Hilda group, which are the counter-examples of the well-known Kirkwood gaps.

Light-Pulse Experiments: P. B. Byrne, B. D. Jordan, F. A. Wayman.

A twin-channel photoelectric detector assembled at Dunsink with the assistance and advice of Dr. J. V. Jelley, of A.E.R.E. Harwell, was taken to South Africa in April for use with the ADH telescope. The project was undertaken with a view to determining whether emission of electromagnetic waves in the direction of the centre of the Galaxy could be detected in the form of pulses which might accompany pulses of gravitational waves as reported by Professor J. Weber. It was realized that the ADH telescope at Boyden Observatory provided specially favourable conditions for making such a test and the sensitivity was considered adequate for detection if  $10^{-9}$  of the gravitational energy were emitted in the visual optical band.

The record consisted of paper charts in order to provide identification of "events" to 1 sec. accuracy and simultaneous recording by frequency-modulated signal on magnetic tapes. The noise record ( $10^{-4}$  of total flux) in two channels was adequately displayed and flashes were seen on these records as deflections above noise level. The large total of 190 hours of records was secured over a period of fourteen weeks on the Galactic Centre and 20 hours covering the small Magellanic Cloud in one channel and 47 Tucanae in the other. The majority of single-channel deflections are due to meteors crossing the  $2^\circ$  field covered by each channel. The analysis, which is still in progress, involves the evaluation of the duration and shape of each pulse, using equipment made available by the Geophysical Section, and a comparison of the statistics given by the simultaneous channels. Attention has been focussed on the occurrence of the shortest pulses ( $< 30$  msec) and the occurrence of light flashes in pairs and triplets. No interpretation is yet available.

Miscellaneous:

S. Flagemann: The isotropy of strong radio sources over the sphere is being investigated by a Monte Carlo method. Random samples over parts of the sphere are generated for comparison with the observed distribution and a test for significance has been constructed.

T. C. Weekes: The possibility of detecting time variations in high-energy cosmic rays was investigated on the basis of their originating in pulsars and being subject to travel times of the order of 200 days. The necessary stability of the magnetic field for time variations to be preserved over such a path-length was found to be high.

### 3. INSTRUMENTS, ETC.

Mechanical Workshop: B. D. Jordan; R. P. Murphy.

Progress has been made in constructing the mechanical stage for the video comparator but this is still not complete due to insufficient workshop facilities. The electronic equipment was inspected by representatives of a firm of scientific instrument makers in November.

In May the vacuum tanks for aluminisation of mirrors were transferred by loan to the Physics Department of the Dublin College of Technology. The older system was in use for some years, taking mirrors up to 16 ins. diameter, while a larger system, for mirrors up to 30 ins. diameter, had never been completed. By March good progress with the installation at Kevin Street of both systems had been made and it is expected that several mirrors will be satisfactorily coated during 1972.

Some work has been done towards assembly of historical instruments and fragments of instruments in the Observatory and minor renovations. The year has been notable in the return in June of the two original Arnold Clocks (constructed 1785-1787 by John Arnold and Son, London). These clocks have been perfectly restored and have been granted to the custody of Dunsink Observatory by the Governing Board of Trinity College. One is original in practically every respect and is adjusted to mean solar time; the other has required the construction of many new parts, and is adjusted to sidereal time. The rates show reliability to a few tenths of a second per day, which is comparable to their original performance, as indicated by the records for the years 1787 to 1790.

Electronics Laboratory: B. D. Jordan, P. B. Byrne.

A modulator and de-modulator for frequency-modulated signals on analogue magnetic tape records was constructed. The use of an



integrated phase lock loop circuit for low-frequency modulation was investigated and satisfactorily developed, together with active filters and stabilised power supply.

A digital read-out system using solid-state digital indicators for providing co-ordinate readings on the Joyce-Loebl microdensitometer was designed and constructed. The display of readings permits reproducible settings to be made to an accuracy of 5 microns in  $x$  and  $y$  and is mounted on the control panel.

The Shortt Clock No.86 was suspended in operation during the year, following the introduction of an accurate speaking clock into the telephone system of the Irish Republic. An electronic slave system is being designed for use with the free pendulum to replace the Synchroslave slave clock. The original equipment will, however, suffer no mechanical modification and will remain in situ.

Electronic Computer: I. Elliott, C. J. Butler.

The IBM 1620 computer remained in constant use throughout the year, averaging about 40 hours per week, with infrequent stops due to maintenance requirements. Detailed plans for replacement with a modern small computer capable of real-time operation were subject to postponement due to the financial commitments required. The possibility of establishing a link to a large installation is being investigated together with the future provision of small special-purpose digital equipment for data processing. A Cartrifile 4196 system has already been purchased for development of the magnetic tape cartridge as a convenient storage medium replacing paper tape. It is envisaged that the Joyce-Loebl ADD equipment will be suitable for automatic measurement of stellar images if programming requirements for this purpose can be developed. A preliminary investigation concerned (i) the accuracy with which a star could be "found" by the machine on an AHH plate and (ii) evaluation of parameters suitable for estimating stellar brightness. Accuracy to about .08mm was achieved, or 6 arc seconds on AHH plates, which is generally satisfactory for identification purposes, and provisional results indicate that a magnitude estimate based on a combination of radius and mean density can be evaluated.

#### 4. MISCELLANEOUS

The opening of the South Dome to the Public on the first Saturday evening of each month from September to April inclusive continued as in former years. On fine nights it is not unusual for several hundred persons to pay such a visit. The Flossel 5-inch portable refractor is also occasionally used in the grounds. Many specially-arranged groups were also received, the staff members chiefly involved being Professor Wayman, Dr. Butler, Dr. Elliott, Mr. Jordan, Mr. Byrne, Mr. Norris and Mrs. Norris. The Dublin Centre of the Irish Astronomical Society used the South Telescope on five nights at monthly intervals.

The Geophysical Section provided a cable linking the rock-bed vault to an outside shed and made regular recordings throughout the year. A caravan for housing the recording equipment is now provided.

From July, members of the Physics Department of University College, Dublin, under Professor N. A. Porter, set up in the grounds of Dunsink an experiment involving movable scintillation detectors of cosmic-ray showers, in conjunction with vertical antennae. A mobile laboratory has been used for this work.

Portions of the copy of the Palomar Sky Atlas have been loaned to the University Observatory, Oxford (Dr. J. V. Peach and Mr. J. Beard) for carrying out a survey of counts of membership of clusters of galaxies and radial distribution. This loan, in force over several years, has now been concluded and all charts returned.

#### 5. BUILDINGS

A small improvement to the rear entrance yard and provision of new car parking space was completed during the year.

Plans are in hand for conversion of the Meridian Room to Library purposes. The historic features of this building will be preserved as far as possible. In order to effect the necessary clearance, Dunsink House, formerly the residence of the Chief Assistant, has been converted to office space and one room has been prepared as a colloquium room. No structural alterations have been made to this house.

6. LECTURES, CONFERENCES, ETC.

A series of thirteen lectures on astronomical topics was given in Trinity College, Dublin, during the Michaelmas and Hilary Terms by Professor Wayman, Professor Kiang and Dr. Elliott. The subjects included introductory material, the emission and absorption of radiation, statistical astronomy, and time-series analysis of solar turbulence.

Professor Wayman presented the Arnold K. Henry Lecture at the Royal College of Surgeons of Ireland on April 3rd, 1971: "The Universe seen by the Astronomer". Other lectures included: January 6th, to the U.C.D. Conference of Science Teachers "Pulsars, Quasars and the new Trends in Astronomy"; December 8th, at the Limerick Regional Scientific Society "Modern Astronomy"; March 8th, to the Institute of Chemistry "The Origin of Chemical Elements".

Popular lectures to the Dublin Centre of the Irish Astronomical Society were given by Professor Wayman, Mr. Byrne, Dr. Butler, Mr. Jordan and Mr. Norris, and to the Belfast Centre by Professor Wayman.

Professor Wayman gave an invited paper "Observations of Cepheid Variables in the Magellanic Clouds" at the Retirement Conference for the Astronomer Royal, Sir Richard van der Reit Wooley, in August 1971.

Professor Wayman attended meetings of the Boyden Observatory Council in London in October 1971 and in Bloemfontein in March 1972. A symposium was held in connection with the second of these meetings and a paper "Composition data from observations of Variable Stars" was read by Professor Wayman.

At a joint conference on Schmidt Telescopes of the European Southern Observatory and the U.K. Science Research Council in Hamburg in March 1972, Professor Wayman gave an invited introductory talk on "Schmidt telescopes in the Southern Hemisphere".

Dr. Butler presented a paper "Photometry of Long Period Variables in the Magellanic Clouds" at the 5th Colloquium on Variable Stars, Bamberg, Bavaria in August, and a further paper "Photometry of Cepheids in the Magellanic Clouds" at the Third Colloquium on Astrophysics, in Trieste in September.

Professor T. Kiang read a paper on "The Past Orbit of Halley's Comet" at the Royal Astronomical Society in April.

#### 7. VISITORS

Mr. C. A. Murray (Royal Greenwich Observatory) and Dr. T. C. Weekes addressed informal colloquia at Dunsink in May and June respectively.

Other visitors during the year included members of the Royal College of Surgeons of Ireland (April 3) and of the Dublin University Experimental Science Association (November 16); also Dr. T. K. Whitaker, Professor A. J. McConnell, Dr. T. W. Rackham, Professor J. J. de Kort, S.J. (Nijmegen) and Professor and Mrs. H. A. Brück (Edinburgh).

#### 8. PUBLICATIONS

Of the nine papers cited in the previous year's Report (1970-71) as prepared for publication, the following have been published:

C. J. Butler: "Photometric Standards in the Magellanic Clouds", Dunsink Observatory Publications Vol.I, No.6, pp.133-192, 1972 (Communications of the Dublin Institute for Advanced Studies, Series C).

P. A. Wayman: "Henry Ussher at Dunsink, 1783-1790", Irish Astronomical Journal, 10, 121, 1971.

T. Kiang: "The Past Orbit of Halley's Comet", Mem. Roy. Atr. Soc. 76, 27, 1972.

T. Kiang: "The Distribution of Asteroids in the Direction Perpendicular to the Ecliptic Plane", IAU Colloquium No.12, NASA, 1972.

The following further papers have been published:

T. Kiang: "An Old Chinese Way of Finding the Volume of a Sphere", The Mathematical Gazette, 56, 88, 1972.

C. J. Butler: "Photometry of Cepheids in the Magellanic Clouds", Proceedings of the Third Colloquium on Astrophysics "Supergiant Stars", Trieste, September 1971, p.128.

C. J. Butler: "Photometry of Long-Period Variables in the Magellanic Clouds", Proceedings of IAU Colloquium No.15, Variable Stars, Veröffentlichungen der Remeis-Sternwarte, Bamberg, IX, No.100, 1971, p.90.

- P. A. Wayman: Report on Symposium on "The New Astronomy"  
University of the Orange Free State, March 1972,  
Mon. Not. Roy. Soc. Astr. South Africa, 31, 45,  
1972.
- T. C. Weekes: "Time Variation in High Energy Cosmic Rays",  
Nature Physical Science, 233, 129, 1971.

The following papers have been communicated for publication:

- P. A. Wayman: "Observations of Cepheid Variables in the  
Magellanic Clouds", Proceedings of the  
Herstmonceux Conference of August 1971.
- P. A. Wayman: "Composition Data from Variable Stars",  
Symposium on the New Astronomy, March 1972,  
University of the Orange Free State.
- P. A. Wayman: "The Use of Schmidt Telescopes in the Southern  
Hemisphere", Proceedings of the Joint E.S.O. -  
S. R. C. Conference, Hamburg, March 1972.
- T. Kiang: "Observational Selection and Statistics of  
Asteroids", IAU Colloquium No.22.
- T. Kiang: "A Note on a Peculiarity in the Distribution  
of the Argument of Perihelion", IAU Colloquium  
No.22.
- T. Kiang: "The Past Orbit of Halley's Comet - A Report  
and an Outline of Further Research", IAU Collo-  
quium No.22.
- B. D. Jordan: "A Frequency Modulation System using Phase Lock  
Loop", Wireless World.

In preparation:

- C. J. Butler & Identification of Variable Stars in the Large  
P. A. Wayman: Magellanic Cloud", Dunsink Observatory Pub-  
lications, Vol.1, No.7.
- M. V. Norris & Short-Period Variable Stars in NGC 1466,  
P. A. Wayman: Mon. Not. Roy. Astr. Soc.

B. Cosmic Ray Section.

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh.

Professor:

K. Imaeda.

Assistant Professor:

M. Kazuno (to 31 December 1971).

Research Assistants:

Dr. D. O'Sullivan; Dr. Y. V. Rao; Dr. A. Thompson.

Experimental Officer:

Mr. J. Daly.

Technical and Clerical Staff:

Miss M. Dalton; Miss E. Byrne; Miss E. Kee; Miss D. Molloy;  
Miss H. O'Donnell; Miss M. Ryan (to 7 January 1972).

Scholars:

T. Cantwell (to 31 August 1971); A. Curran (to 30 September 1971).

2. RESEARCH WORK

European K<sup>-</sup> Collaboration: T. Cantwell (with others).

The second phase of the work on  $\Sigma$ -hyperons has been completed and the results have been submitted for publication in Nuclear Physics. This study involved the determination of the masses of the charged  $\Sigma$ -hyperons from the ranges in nuclear emulsion of particles resulting from the interactions of K<sup>-</sup>-mesons at rest on hydrogen,  $K^- + p \rightarrow \Sigma^+ + \pi^-$ , and also from the range of the proton from  $\Sigma^+$  hyperon decays at rest,  $\Sigma^+ \rightarrow p + \pi^0$ . The mass of the  $\Sigma^+$  hyperon was found to be  $1189.38 \pm 0.07$  MeV, while that of the  $\Sigma^-$ -hyperon was  $1197.29 \pm 0.24$  MeV., in excellent agreement with the world averages.

The results of this work also provide conclusive evidence for the contention that negative particles with low velocities lose energy at a slower rate than do positive particles of the same mass and velocity.



In a study of hypernuclei, a total number of three million  $K^-$ -meson interactions were recorded. A total sample of 27,000  $\pi^-$ -mesonically decaying hypernuclei was obtained. First examples of the hitherto unobserved hypernuclei,  $^9_{\Lambda}B$  and  $^{10}_{\Lambda}Be$ , as well as some new decay modes of known hypernuclei, were found. As well as confirming the existence of particle-unstable excited states of  $^{12}_{\Lambda}C$ , some evidence was found to suggest the existence of particle-unstable excited states of the hypernuclei  $^{14}_{\Lambda}N$  and  $^{16}_{\Lambda}O$ .

The work on the determination of the value of  $Q^-$ , the non-mesonic to mesonic decay ratio, is still in progress. Work on the investigation of final state interaction effects amongst the nuclear decay products of hypernuclei has been initiated.

Mr. Cantwell having taken up an appointment at the College of Technology, Kevin Street, Dublin, it was arranged to make available to the College on loan one Cooke, Troughton and Simms M. 4000 nuclear research microscope, one metal filing cabinet containing records of experimental measurements, exposed photographic emulsion plates and the Dublin share of the material of the Collaboration. This action was taken because of a request for the loan in order to allow Mr. Cantwell to continue his research work in collaboration with the  $K^-$ -Collaboration. It has been agreed that all published material based on work carried out during the tenure of Mr. Cantwell's Scholarship will give as his address 'School of Cosmic Physics, Dublin Institute for Advanced Studies'.

Study of Charge Spectrum of Heavy and Very Heavy Nuclei in Cosmic Radiation:

C. Ó Ceallaigh, D. O'Sullivan, Y. V. Rao and A. Thompson, assisted by J. Daly, Miss D. R. Molloy, Miss E. Byrne, Miss E. Kee, Miss H. O'Donnell and Miss M. Ryan.

The material described in the preceding report which had been stored in Minneapolis, Minn. in September 1970, was transported to Foss Airfield, Sioux Falls, S.D. in late April 1971 for flights carried out by Raven Industries Inc. The Bristol-Dublin team reassembled the modules on refurbished frames in preparation for the flights. The

Dublin contingent consisted of C. Ó Ceallaigh, J. Daly and Miss D. Molloy.

The material to be exposed consisted of sixty modules composed of stacks of lexan polycarbonate and photographic emulsions interleaved with brass sheets of varying thickness. Each module weighed  $\approx 55$  lbs. The total load was divided equally between two flights and was carried by 20.8 million cubic foot helium-filled balloons. The first flight launched on the morning of 7th May was aloft for 43 hours before descending in difficult terrain 60 miles N.E. of Alliance, Neb. Due to high surface winds at impact, the parachute failed to collapse and the load was dragged for three miles before being brought to rest by a wire fence. Some damage occurred, but 85% was in usable condition.

The second flight was launched on the morning of 12th May and after remaining within sight of Sioux Falls for the first day then came into a north-going airstream which it maintained with increasing velocity. The flight was cut down 15 miles south of the Canadian border but eventually came to rest east of Boissevain, Manitoba. Due to failure of the command mechanism for disconnecting the parachute, the load was trailed for about three miles suffering some damage. The total elapsed time for the second flight was 52 hours. In both cases, the average altitude was  $3.5 \text{ gms cm}^{-2}$  of residual atmosphere ( $\sim 125000$  feet).

The exposed material from each flight was divided equally between Dublin and Bristol. The processing and scanning of the stack and the measuring and analysis of the cosmic ray events has continued during the year. A total of 33 ultra heavy cosmic ray candidates were found in Dublin and Bristol, 17 of these having nuclear charge greater than sixty ( $Z > 60$ ). In addition to the work on the ultra heavy nuclei a sample of 200 stopping nuclei with  $Z \leq 30$  have been fully measured and analysed.

A second stack was assembled during July and August 1971. This was similar in design to the previous stack and consisted of twenty

modules having a total collecting area of five square meters. An attempt to expose this stack was made in September 1971 using a new type of Raven balloon of volume  $33 \times 10^6 \text{ ft}^3$  launched at Sioux Falls. The objective was to attain a considerably greater altitude and flight duration than hitherto. The attempt failed possibly due to a freak atmospheric disturbance which damaged the balloon during the initial stages of the ascent. However, the stack was recovered intact and was stored at Sioux Falls with the intention of making another attempt in May 1972.

During March 1972 a third stack was constructed. This stack embodied rather different design principles and consisted of seven double-sized modules giving a total collecting area of 3.5 square metres. Three of the double modules employed layers of absorber and Lexan in two linear distributions followed by a block of 12 Lexan sheets. A layer of emulsion at top and bottom completed the ensemble. The other four double modules employed a pure Lexan configuration consisting of 200 layers of Lexan with emulsion at top and bottom. It is intended to use these pure Lexan modules to study cosmic ray nuclei in the region  $30 \leq Z \leq 60$ . It is planned to expose the third stack in May 1972.

Dublin-CERN Collaboration: C. Ó Ceallaigh, D. O'Sullivan and A. Thompson.

Preparatory work for the full scale nuclear fragmentation experiment at the CERN Proton Synchrotron continued during the year. The main objective of this work is to search for the rare very heavy and relatively high energy nuclear fragments which have been predicted to occur in the interactions of high energy (28 GeV in this case) protons with heavy target nuclei such as gold or uranium. This work is a natural complement to our search for ultra heavy nuclei in the cosmic radiation.

A high vacuum exposure chamber has been constructed at CERN and will be installed in a 28 GeV proton beam transport system at the earliest available date in the Proton Synchrotron operations schedule. This will probably take place in September 1972. Special stack holders

have been designed and constructed to facilitate the exposure of small Lexan stacks in the vacuum chamber and to increase the precision of the subsequent location and re-location of the heavy fragment tracks if such are produced against a high background of other nuclear fragment tracks.

Study of Ultra High Energy Nuclear Lower Case Interactions in Photographic Emulsions:

K. Imaeda, M. Kazuno, P. Fleming and A. Curran.

K. Imaeda: The study of ultra-high energy nuclear interactions has been continued. The liquid model of a hadron gas has been extended to a hadron gas having non-zero baryon number and has been applied to high-energy nuclear interactions both of cosmic ray ( $\geq 10^{12}$  eV) and accelerator energies. Interactions at accelerator energies have been studied extensively both experimentally and theoretically. Consequently, we have been able to compare the predictions of our model with previous experimental results. The characteristic features of the model are (1) A logarithmic increase of the interaction radius of a nucleon. With increasing radius, however, the nucleon becomes more transparent, so that the total cross-section remains nearly constant. This prediction of constancy of total cross-section is in agreement with experimental results obtained at cosmic-ray energies. (2) Incorporation of the Feynmann scaling laws in the very high energy region, and (3) a fireball structure of meson production.

M. Kazuno: Studies of the role of baryon resonances in ultra-high energy interactions were continued.

K. Imaeda and P. Fleming: The characteristics of nuclear interactions produced by high-energy cosmic-ray nuclei in collision with light nuclei in emulsion have been studied.

A. Curran: An analysis of ultra-high energy nuclear interactions (ICEF jets) had been performed using a computer to extract information concerning the angular distribution of the secondaries. This work has led to two publications which are listed under the appropriate heading.

3. WORKSHOP AND TECHNICAL DEVELOPMENT - J. Daly.

A large twelve-bay set of slides to accommodate sixty stack-holders each carrying five 6" x 3" Lexan polycarbonate sheets was built and fitted to the etching tank thus increasing its capability and versatility.

A malfunction in the electronic displacement measuring equipment on the microscopes was corrected by making slight alterations to the circuits and replacing critical components with high quality units. To date, the performance of the modified units has proved to be very satisfactory.

A modern type airflow fume cupboard was assembled and installed in one of the laboratories.

A period of ten days from 10th to 20th February 1972 was spent at CERN, Geneva in designing a precision locating system for lexan detectors at the proton synchrotron. This work is now in hand in Geneva. The stack holders for this experiment are to be made in Dublin.

In September 1971 a period of three weeks was spent at Sioux Falls, S.D., U.S.A. assisting at the launching and recovery of the 30 million cubic foot balloon which, as already noted, failed at a height of 25,000 feet for reasons which remain largely conjectural.

The general maintenance of equipment in the laboratories continued.

4. NATIONAL SCIENCE COUNCIL RESEARCH GRANTS

The National Science Council Research Grant was continued for a second year.

5. CONFERENCES, MEETINGS ETC.

The following meetings and international conferences were attended by members of the Section:

European K<sup>-</sup> Collaboration Meetings. Warsaw 9-21 May, 1971;  
Brussels 27 June - 1 July, 1971. (T. Cantwell).

Physics III Committee Meetings at CERN, Geneva. October, 1971;  
January, 1972. (C. Ó Ceallaigh).

Conference of Institute of Physics, Irish Branch. Carrickmacross  
25-26 March, 1972. (D. O'Sullivan and A. Thompson).

Bristol-Dublin Collaboration Meetings were held as follows:

(a) at Bristol University, 7 April, 1971. D. O'Sullivan and  
Y. V. Rao visited Professor P. H. Fowler for discussions on the  
Dublin-Bristol cosmic ray programme.

(b) at Bristol University 13-17 June, 1971. (D. O'Sullivan,  
Y. V. Rao and A. Thompson). On this occasion, the Nebraska and  
Manitoba modules were disassembled and transfer of DIAS share of the  
exposed material was arranged.

(c) at DIAS, Dublin, 1 February, 1972. Attended by Professor  
P. H. Fowler and R. Thorne together with C. Ó Ceallaigh, D. O'Sullivan,  
Y. V. Rao and A. Thompson.

15th Herstmonceux Conference on the abundances of elements,  
Herstmonceux, England. 5-6 April, 1971. (D. O'Sullivan and  
Y. V. Rao).

CERN - DIAS Collaboration: D. O'Sullivan visited Geneva from  
27 June to 5 July, 1971 for discussion with Dr. Hertz on proposed  
nuclear fragmentation experiment at the CERN proton synchrotron.

## 6. PUBLICATIONS

(a) Published:

T. Cantwell (with others of the  $K^-$  Collaboration):

On the Existence of the Hypernucleus  $^8_{\Lambda}\text{He}$ . Nuclear Physics  
B35, 160 (1971).

Some Properties of the Charged  $\Sigma$  Hyperons. Nuclear Physics  
B33, 493 (1971).

K. Imada, M. Kazuno and P. Fleming:

Elastic scattering of target protons in nucleon-nucleus  
Collisions. Lett. Nuovo Cimento I, 596 (1971).

A. J. Curran:

An application of Wataghin's method in the analysis of ultra-  
high-energy interactions. Lett. Nuovo Cimento 2(26A), 285  
(1971).



A. J. Curran:

The dispersion energy relation for ultra-high energy nuclear reactions in emulsion. J. Phys. A. Gen. Phys. 4, 888 (1971).

(b) In the press:

T. Cantwell (with others of the  $K^-$  Collaboration):

Further Evidence for the Existence of Particle-Unstable States of  $^{12}_6C$ . Nuclear Physics.

A determination of the Masses of the charged  $\Sigma$  Hyperons. Nuclear Physics.

A New Determination of the Binding Energy Values of the Light Hypernuclei ( $A \leq 15$ ). Nuclear Physics.

A Note on the Hypernucleus  $^4_{\Lambda}h \rightarrow \pi^- ^3He$ . Nuclear Physics.

(c) In preparation:

C. Ó Ceallaigh, D. O'Sullivan, Y. V. Rao, A. Thompson and the Bristol Group:

High Resolution Study of Ultra-Heavy Cosmic Ray Nuclei. To be read at the Bucharest Conference, July 1972.

K. Imseda and P. Fleming:

Nuclear Interactions by High-energy Nuclei with Light Nuclei in Emulsion.

T. Cantwell (and others of the  $K^-$  Collaboration):

A determination of  $Q^-$ , the Non-Mesonic to Mesonic Decay Ratio.

Final State Interaction Effects in Light Hypernuclei.

Evidence for the Existence of Particle-Unstable States of  $^{14}_7N$  and  $^{16}_8O$  Hypernuclei.

## 7. LECTURES, COLLOQUIA etc.

Dr. A. Thompson delivered a lecture on The Charge Distribution in Superheavy Primary Cosmic Ray Particles, at the Institute of Physics (Irish Branch) Conference in Carrickmacross, in March 1972.

The Statutory Public Lecture which was to have been delivered by Professor P. H. Fowler of Bristol University was cancelled owing to apprehension as to the political situation. Professor Ó Ceallaigh undertook to deliver a lecture in its stead as early as possible in April 1972.

8. PERSONAL

Miss M. Ryan, appointed 9 December 1968, resigned her post as Junior Technical Assistant on 7 January 1972.

A. J. Curran was awarded the degree of Ph.D. of the University of Dublin in September 1971. He was also awarded a European Traveling Fellowship of the Royal Society, London, tenable for a period of six months. It is intended that the fellowship will be taken up at University College, London in July 1972.

Mr. T. Cantwell was appointed to a teaching post in the College of Technology, Kevin Street, Dublin where he intends to continue his research work within the European K<sup>-</sup> Collaboration.

Professor C. Ó Ceallaigh was appointed to the Council of the European Physical Society.

C. Geophysical Section

1. STAFF AND SCHOLARS

Senior Professor:

T. Murphy.

Professor:

Vacant.

Research Assistant:

D. G. G. Young (with leave of absence 17 September to 31 December 1971).

Senior Technical Assistant:

T. J. Morley.

Research Associates:

Rev. G. McGreevy (Maynooth College); P. Morris (Trinity College);  
K. W. Robinson (Geological Survey).

Technical and Clerical Staff:

Miss A. Byrne; Miss E. Ryan; K. Bolster; J. Fay (to 31 January 1972);  
C. Pearn (from 23 June to 27 August 1971); D. Clarke (from 26 July to  
27 August 1971); Mrs. P. Brück (part-time from 1 November 1971);  
Mrs. S. Leonard (part-time from 28 March 1972).

Scholar:

D. Howard.

2. RESEARCH WORK

(a) Gravity and magnetic fieldwork:

For some time past commercial companies prospecting for minerals in Ireland have shown a great interest in the results of the gravity survey and to satisfy their demands copies taken from our manuscript maps have been supplied to them at a nominal price. It was decided that as a demand existed the results should be presented as published maps on a scale of  $\frac{1}{2}$ " to one mile in conjunction with the Ordnance Survey. A start was made on this scheme and additional fieldwork to fill-in certain gaps was carried out in the midlands by Professor Murphy and Dr. Young. This particular area was chosen not only on account of its possible economic importance but because it contains many unusual phenomena of scientific interest which, however, require rather detailed

investigation. Mrs. Brück, as drawing assistant, has been engaged in processing and contouring the data of this and other areas. It is the intention that eventually all the results will be published in a series of maps.

The work at Kingscourt has turned out to be complex and has not been completed. Meanwhile the Geological Survey have been carrying out further work there and advantage will be taken of this new geological investigation.

Dr. Young continued his analysis of the gravity effects of granite bodies in Co. Donegal and carried out a survey over the Cavan granite. From these studies and from a similar body surveyed by Mr. English some years ago in Co. Mayo it appears that the gravity anomaly can be better represented as a cylindrical disc rather than a cylindrical plug. The geological implications of this unexpected result are being investigated. The diameters are of the order of 10 km which appear to be a second characteristic.

The final years records of the magnetic survey west of Ireland carried out by the Department of Physical Oceanography, University of Wales were handed over to us and Dr. Young has been engaged in drawing up the results. The preliminary analysis shows that the area covered is, in general, not similar magnetically to Ireland nor to an oceanic crust.

Mr. Howard's gravity and magnetic fieldwork in Co. Kerry was completed and the results were compiled as a thesis for M.Sc. in Trinity College. His findings were that the regional gravity anomaly pattern is best interpreted by the presence of an acidic intrusion under the Reeks area with a negative density contrast to the surrounding basement rocks, gentle relief in the basement and by a great accumulation of sedimentary rocks of varying densities. Local anomalies are caused by tectonic activity coupled with weathering, limestone solutioning and Silurian topography. Faults with high dip were located in the approximate position of the "Armorican Thrust Front" of the Geological Survey. The basement is weakly magnetic but contains a strongly magnetic igneous

intrusion which dominates the magnetic map. It appears to be influenced by tectonics. A river channel was also discovered at Glenbeigh which caused complications to the analysis of the gravity field there.

(b) Meteorology:

Routine observations of the meteorological elements were continued throughout the year, the autographic records tabulated and the results published. Back numbers for the years 1961-1963 were also published and distributed.

(c) Seismology:

The investigation of the records from the portable seismic stations was continued but delayed by difficulties in obtaining suitable electronic band pass filters. It has been found that the phenomenon mentioned in last years report is widespread and recognised by a few other workers. It concerns the presence of frequencies greater than 10 Hz on records taken at distances from the source in excess of several hundred kilometres. Their origin is unknown.

Records of quarry blasts have also been made and one of the most interesting results is the probability that deep reflections from the base of the crust can be easily detected. This arises from the unexpected result that different blasts from the same quarry to the same recording station give almost identical records suggesting that the record is characteristic of the path and not of the explosion.

(d) Palaeomagnetism:

This work is being carried out by the Research Associate, Dr. Morris, and the Section at present only assists in helping to collect rock samples.

(e) Rock Sample Data:

Dr. Morris has assembled the data on the density, remanence and susceptibility of the rock samples, about 6,000 specimens from 1,750 sites. Mrs. Leonard has just commenced to classify the rock types to enable the data to be statistically analysed for publication. A provisional list of data is available.

### 3. CONFERENCES AND MEETINGS

The following have been attended by members of the Section:

Geological Society of Edinburgh and Institution of Mining and Metallurgy Combined Meeting, Edinburgh, September 8-11, 1971. (Murphy).

Irish Geological Association Symposium, Galway, November 5-7, 1971. (Murphy and Howard).

Northern Universities Geophysical Meeting, Glasgow, December 8, 1971. (Murphy).

### 4. PUBLICATIONS

Published:

P. Morris:

Preliminary palaeomagnetic results from some Irish limestones of Carboniferous age. Sci. Proc. R.D.S. A, 45-55.

Two component magnetisation in Irish Carboniferous limestone. Earth Plan. Sci. Letters, 12, 350-354.

P. Morris and K. W. Robinson:

Some Palaeomagnetic results from the Ordovician andesites of Co. Dublin and Co. Kildare, Ireland. Geol. Surv. of Ireland Bulletin, 1, 151-161.

T. Murphy, D. G. G. Young and P. Brück:

The post-Deiradian strata along the north west coast of Lough Foyle, Inishowen, Co. Donegal. Proc. R.I.A. B, 71, 181-191.

R. P. Riddihough:

Diurnal corrections to magnetic surveys - an assessment of errors. Geophys. Pros. 19, 552-567.

W. B. Stanford  
CHAIRMAN.

29th September, 1972.